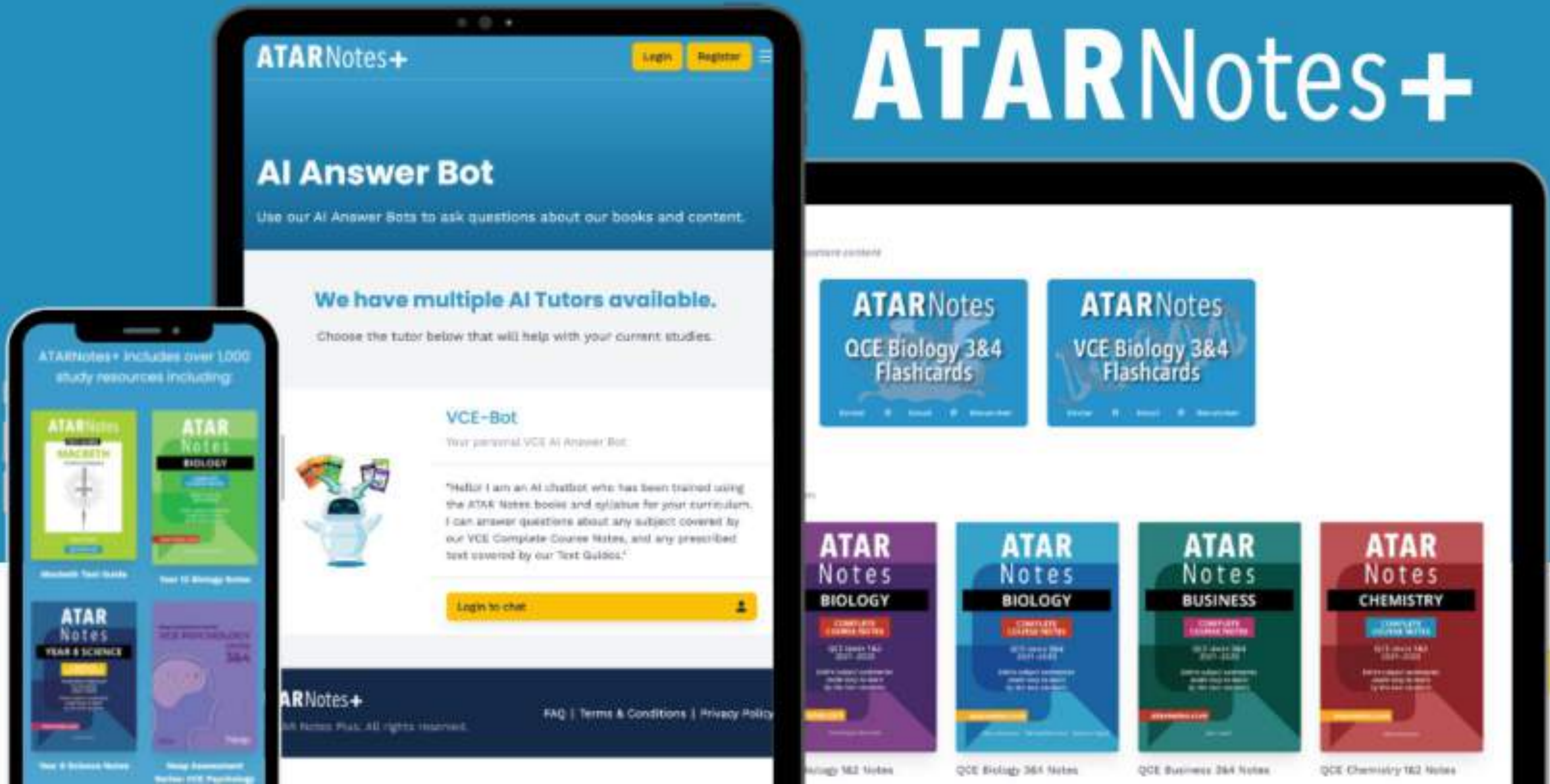
Welcome!

ATARNotes

HIGH SCHOOL RESOURCES

Success for all students

Thousands of Study Resources



ATARNotes

Physics Unit 1&2
HEAD START LECTURE
January

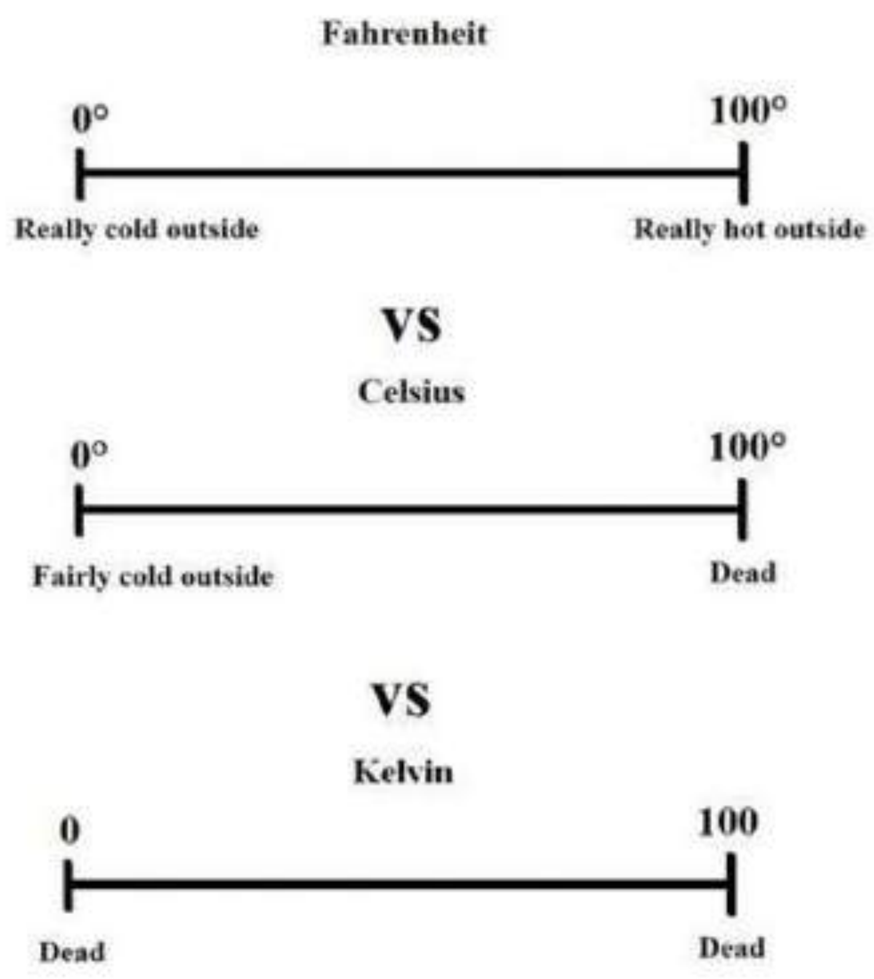
What to expect in this lecture

Topics to be covered

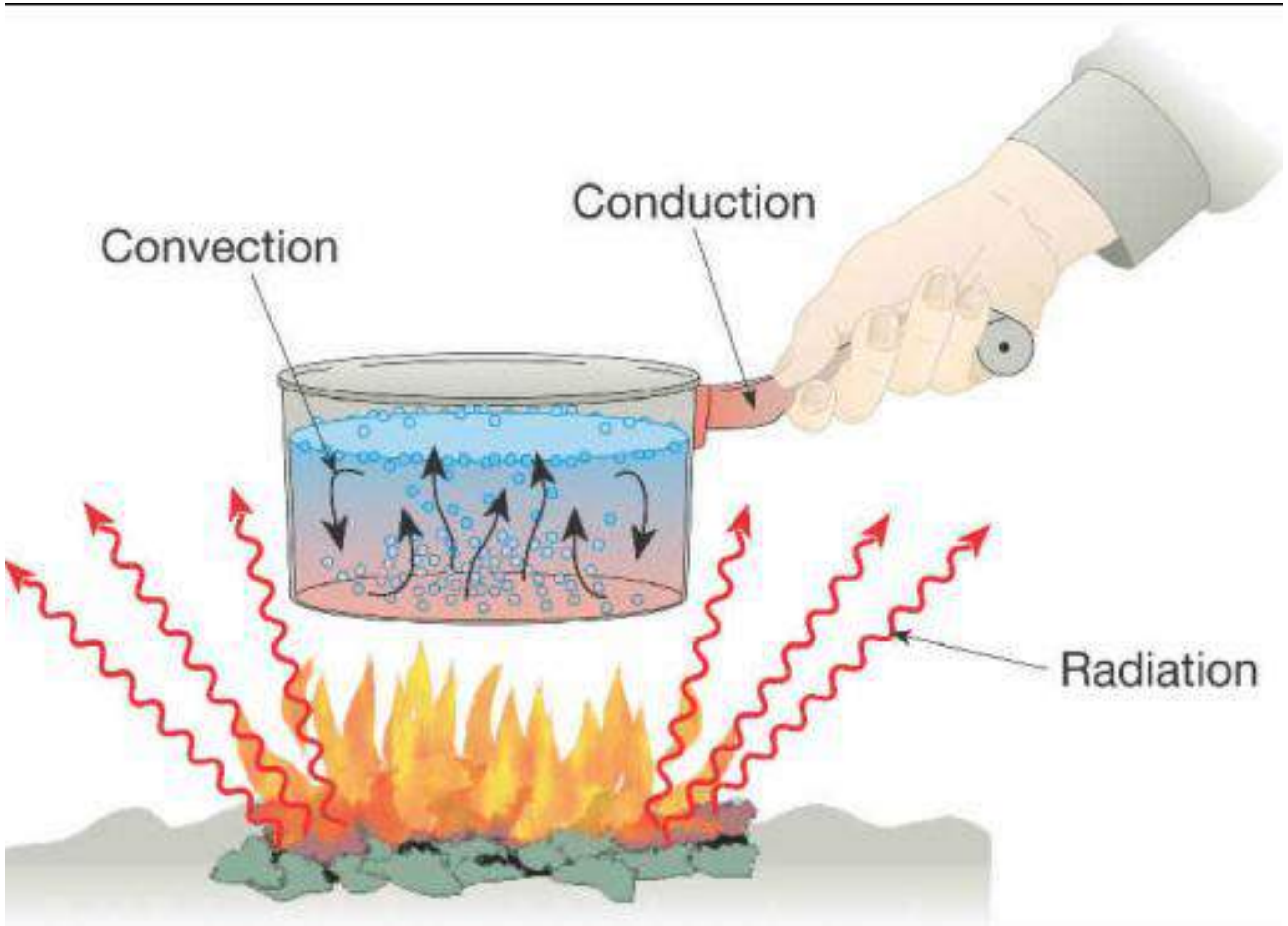
- Area of Study 1: How can thermal effects be explained?
- Area of Study 2: How do electric circuits work?
- Area of Study 3: What is matter and how is it formed?
- Scientific Skills
- Summary

- **Celsius:**
  - -273.15 is absolute 0 (i.e. lowest possible temperature)
  - 0 is the boiling point of water
  - 100 is the boiling point of water

- **Kelvin:**
  - 0 is absolute 0 (i.e. lowest possible temperature)
  - increments are the same size as in Celsius
  - To find, add 273.15 to the Celsius temperature



- Zeroth Law: two bodies in contact with each other coming to a thermal equilibrium | If A=B and B=C then C=A
- First Law: Basically conservation of energy
  Q (heat) = ΔU (internal energy) + W (work by system)
  - internal energy: the energy associated with random disordered motion of molecules
- You don't need to worry about laws 2 & 3. They concern entropy.

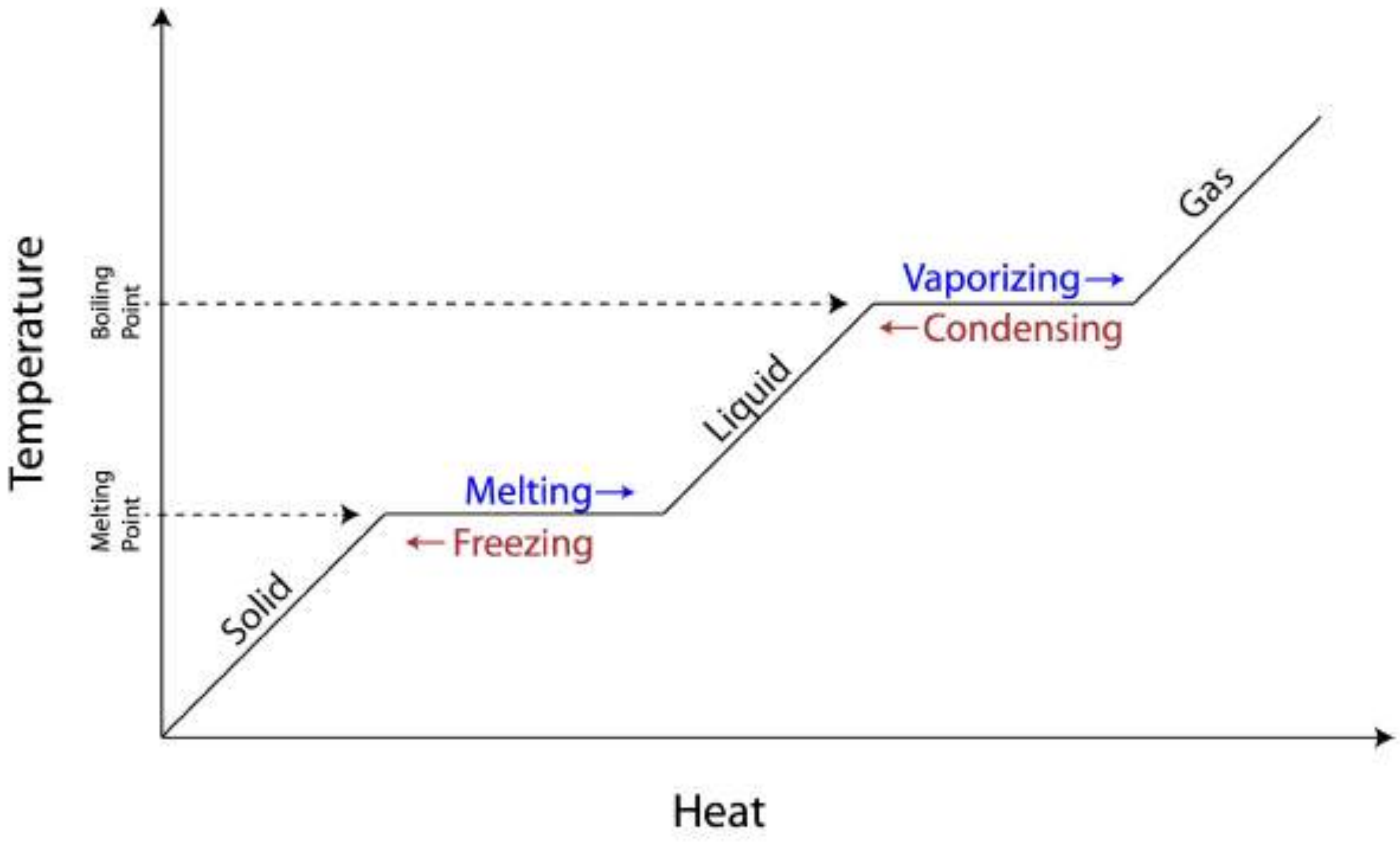


Convection: The medium itself moves (e.g. hot air rising)

Conduction: Particles in the medium pass heat along to their neighbour

Radiation: Heat is passed along without requiring a medium

Energy inputs and temperature

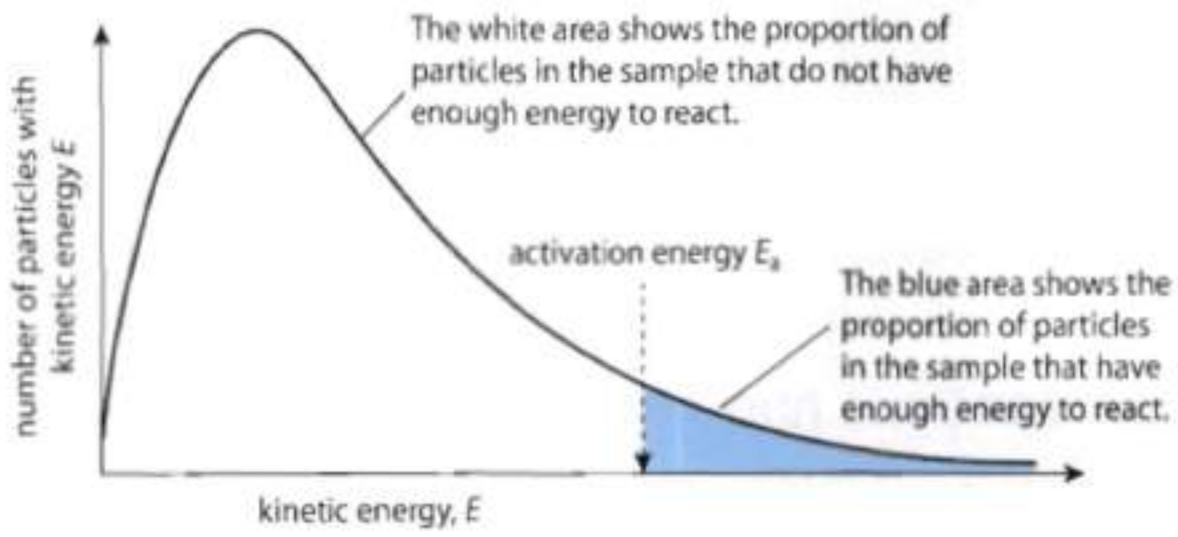


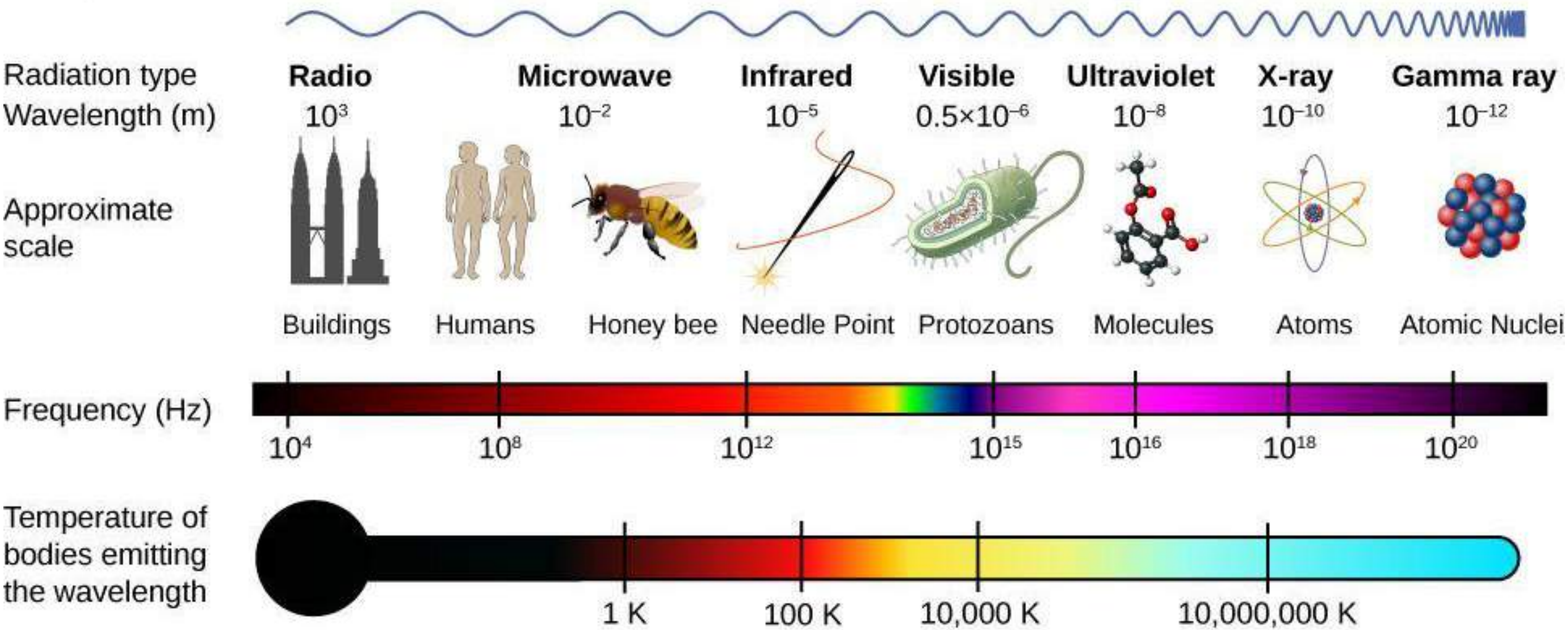
$$Q = mc\Delta T$$

$$Q = mL$$

Evaporative cooling

When something evaporates, it leaves the liquid → Particles with higher energy are more likely to leave → Evaporation decreases the amount of high energy particles → Evaporation decreases the overall temperature





Radiation type
Wavelength (m)
Radio
10^3
Microwave
10^-2
Infrared
10^-5
Visible
0.5×10^-6
Ultraviolet
10^-8
X-ray
10^-10
Gamma ray
10^-12
Approximate scale
Buildings
Humans
Honey bee
Needle Point
Protozoans
Molecules
Atoms
Atomic Nuclei
Frequency (Hz)
10^4
10^8
10^12
10^15
10^16
10^18
10^20
Temperature of bodies emitting the wavelength
1 K
100 K
10,000 K
10,000,000 K

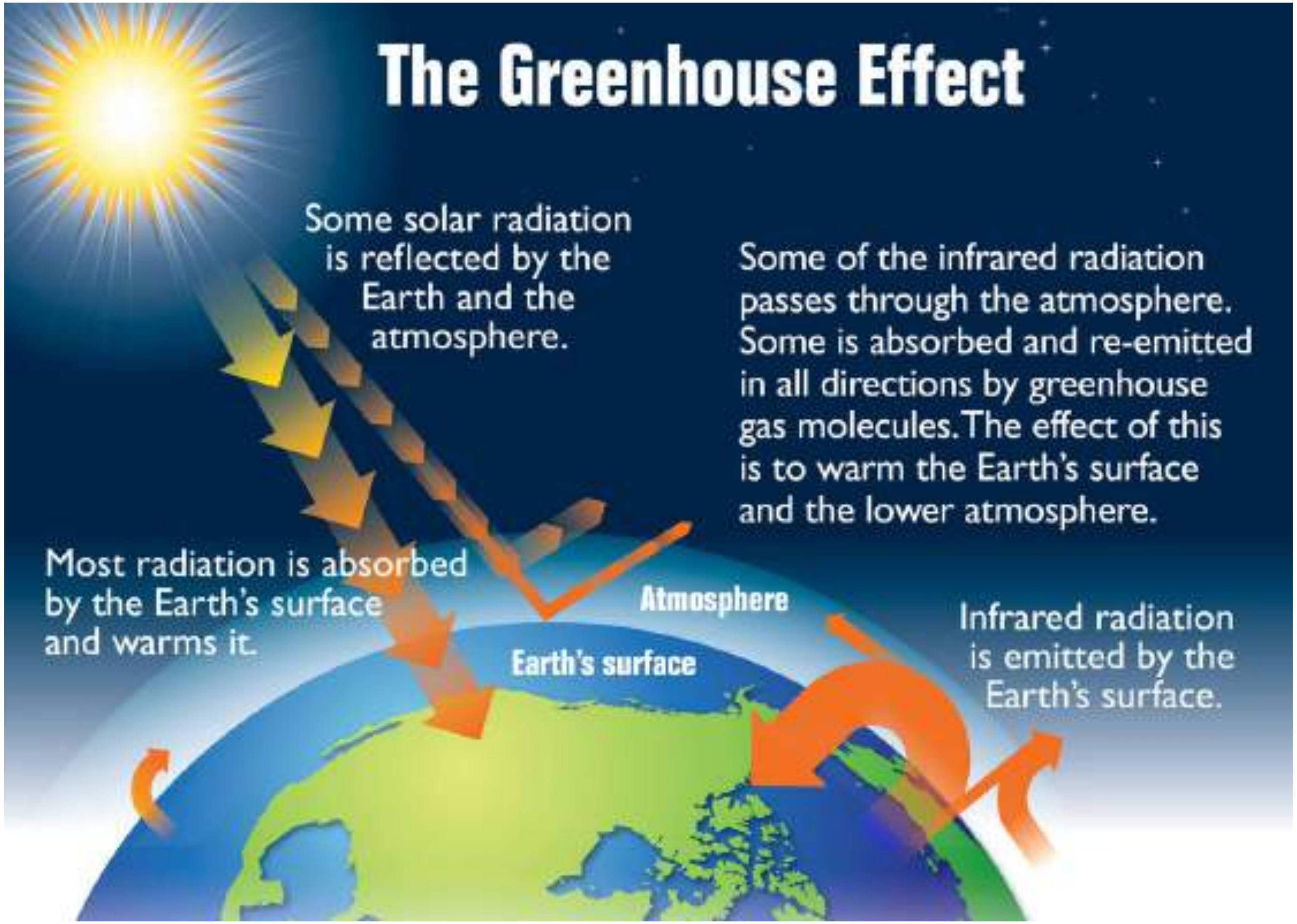
Wien & Stefan-Boltzmann

- $$T\lambda_{max} = b$$

- λ_{max} is the peak wavelength in metres
- b is Wien's displacement constant: 2.898×10^{-3} m K
- T describes the temperature <u>in Kelvin</u> - please don't forget to convert from Celsius!

$$P \propto T^4$$

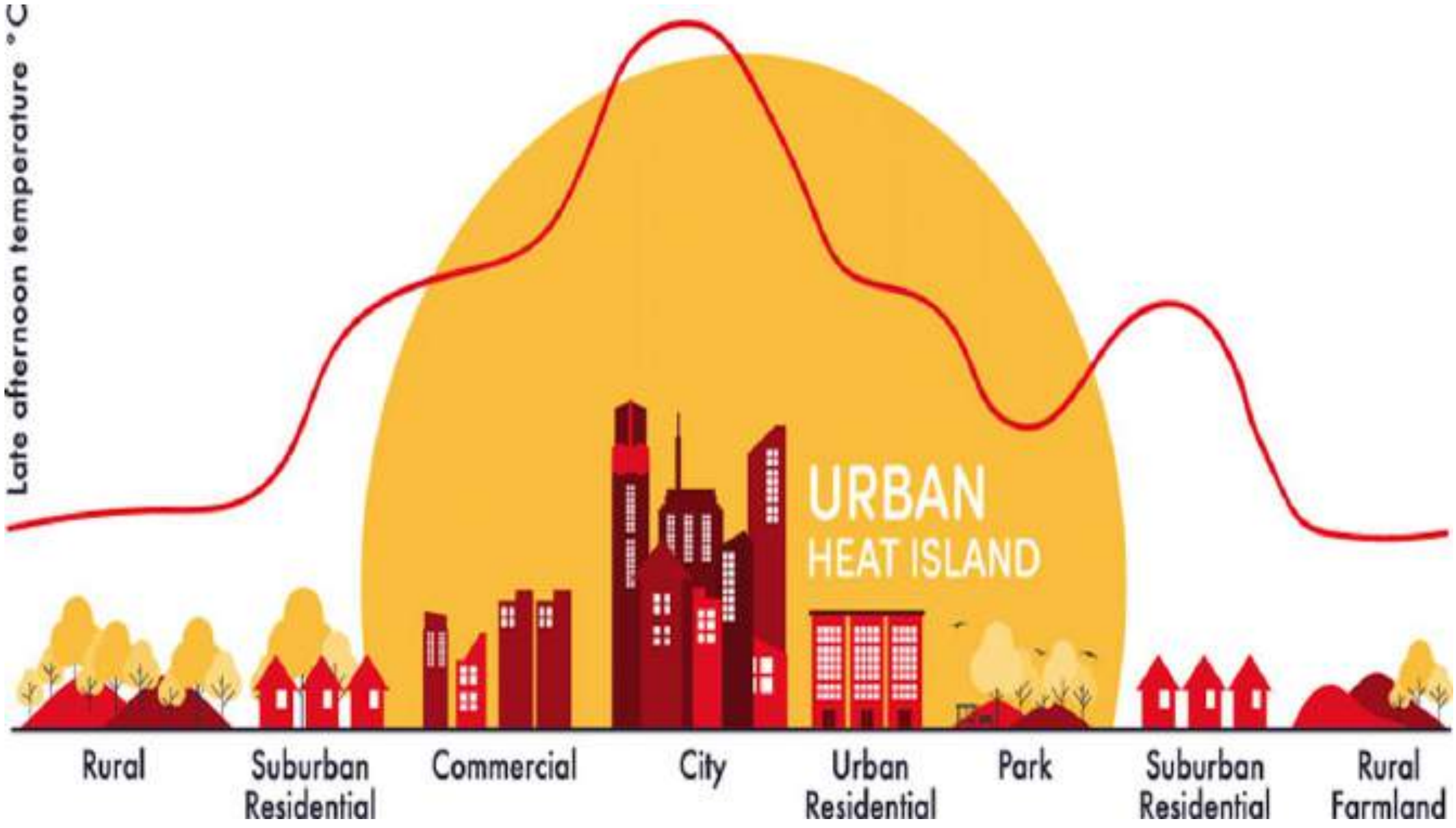
- T describes the temperature <u>in Kelvin</u> - please don't forget to convert from Celsius!
- P describes the power (remember this is energy per unit time)



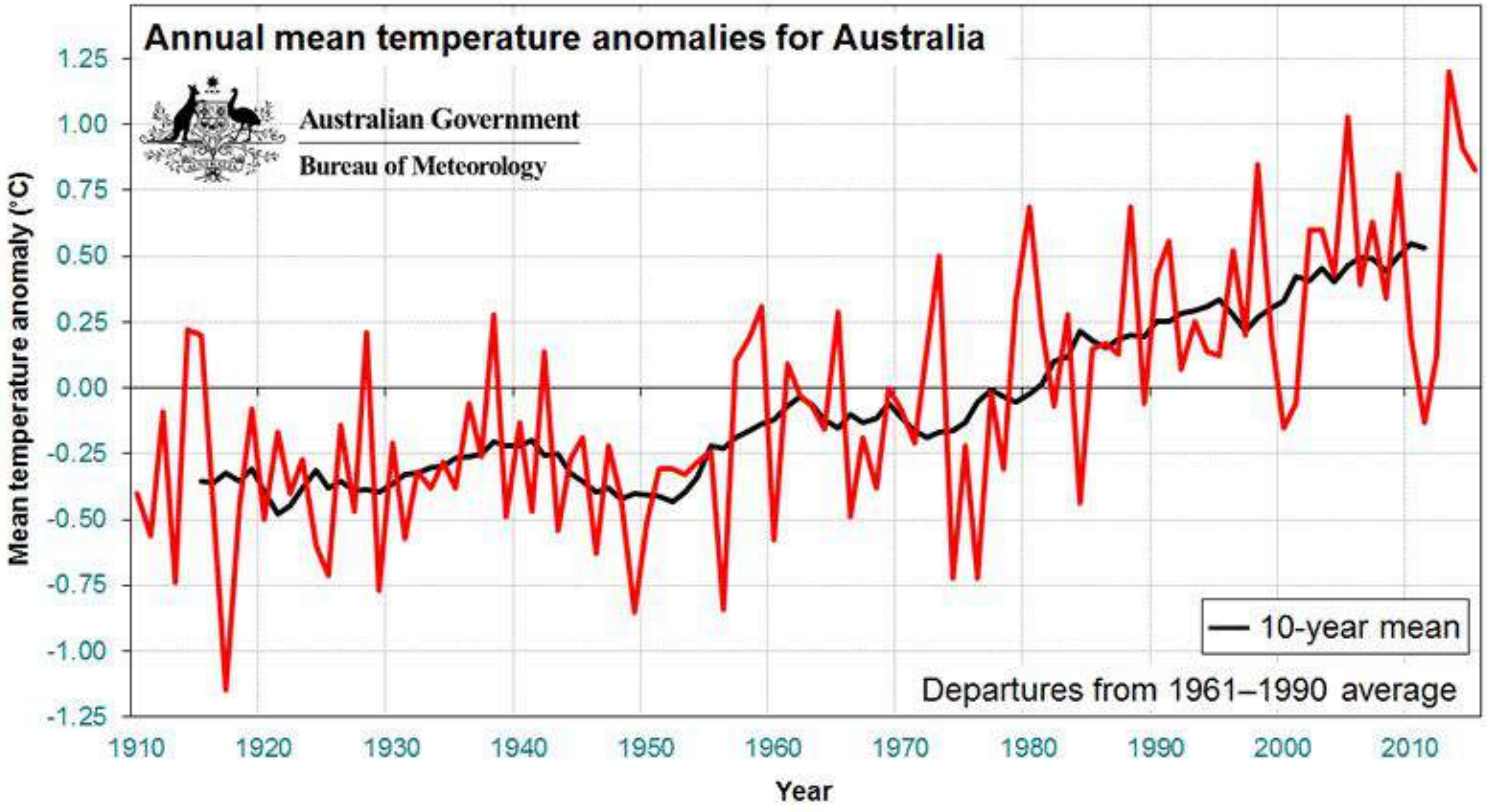
GHG examples:

- water
- methane
- carbon dioxide

Urban heat island effect

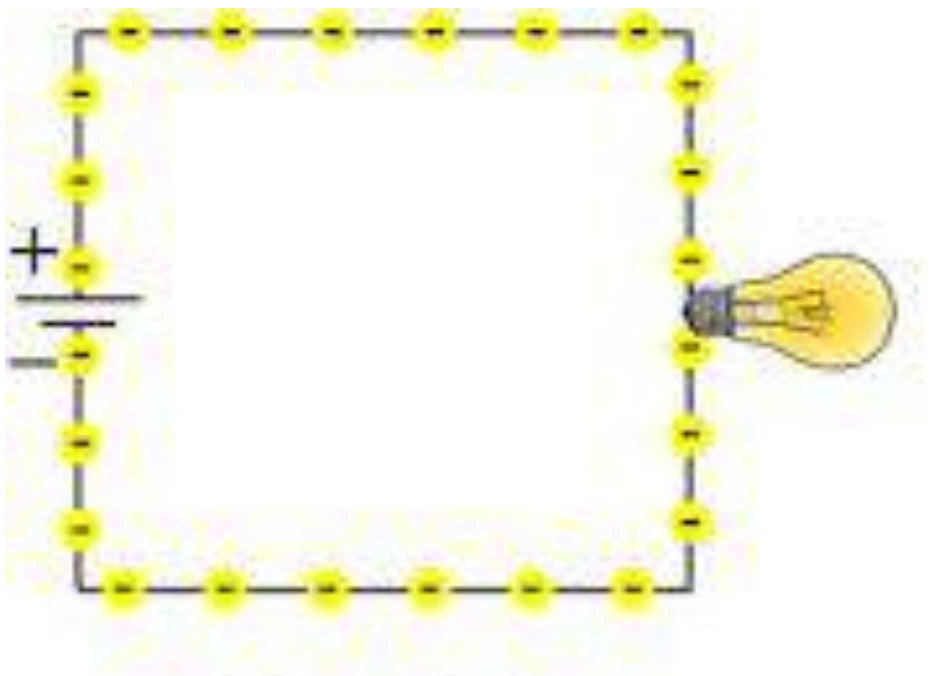


Evidence on global warming

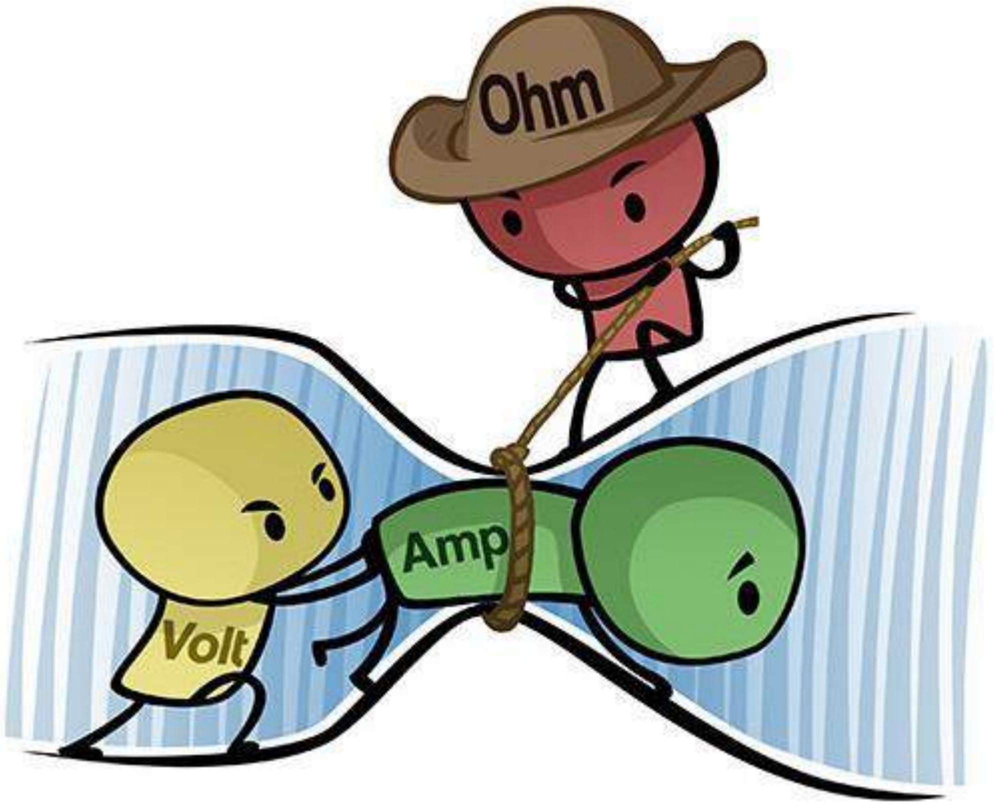


- A voltage source in a closed circuit will have two ends. A positive and a negative

- While the electrons actually flow from negative to positive, we consider the direction of current flow to be positive to negative
- This is called **conventional current.**



closed circuit



$V = IR$

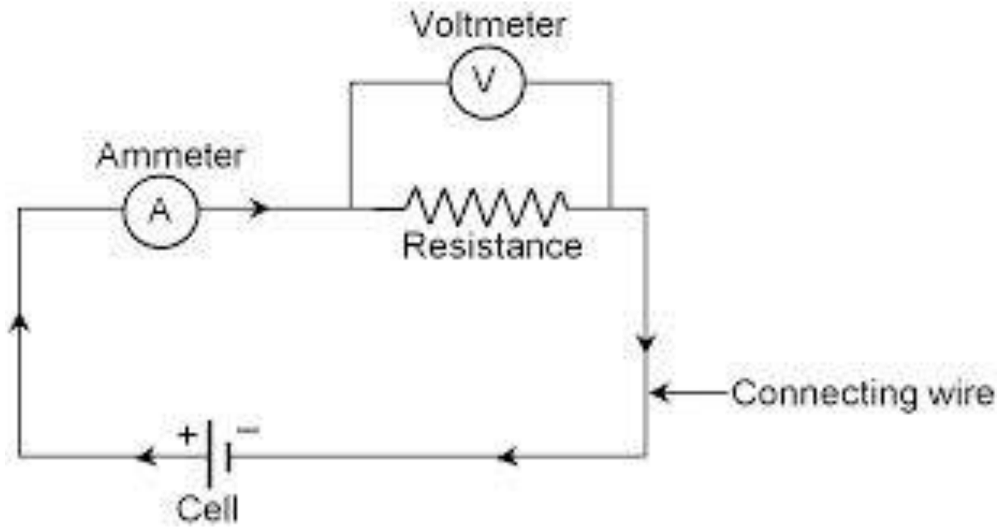
Power is still energy per unit time $P = E/t$

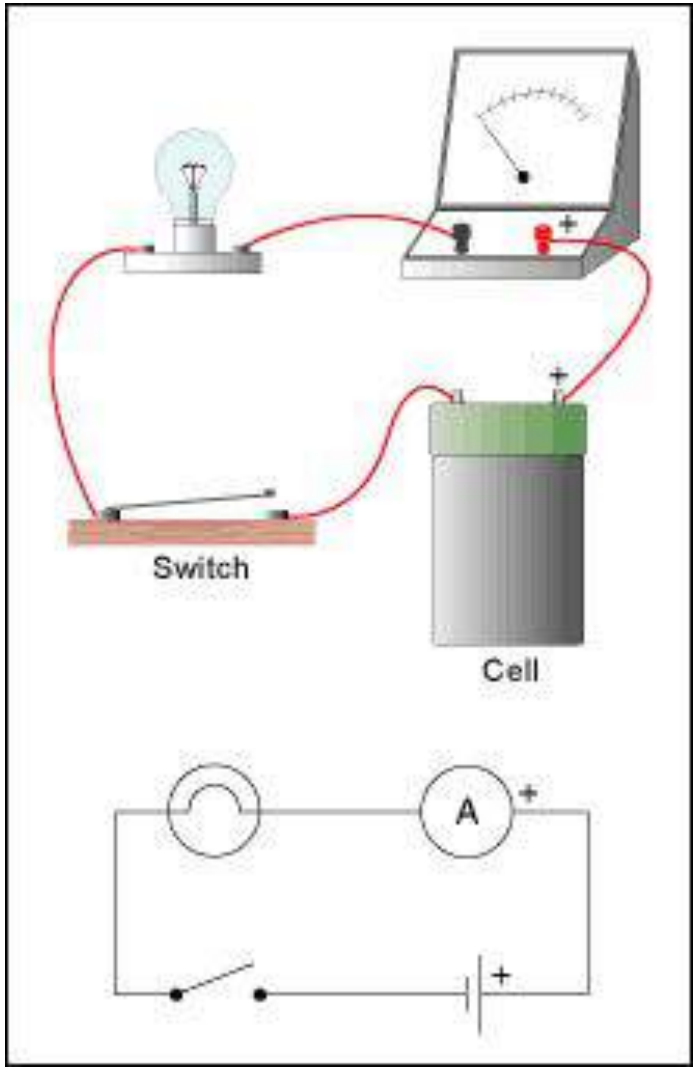
Resistance (R) is measured in **Ohms (Ω)**

Current (I) is measured in **Amperes/Amps (A)**
Current is how quickly charge flows through $I = Q/t$

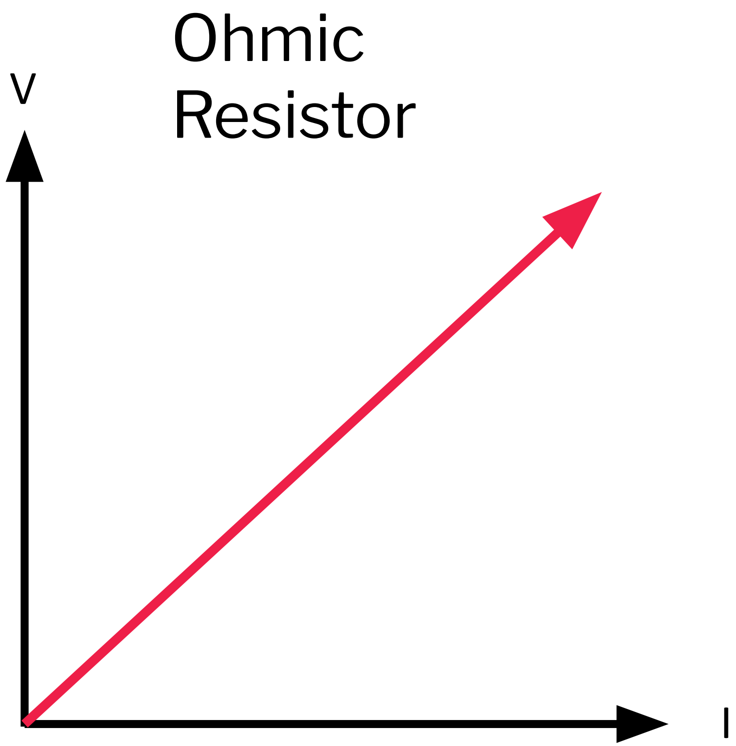
Voltage/Potential Difference (V) is measured in **Volts (V)**
Voltage is the difference in potential supplied to the charges $V = E/Q$

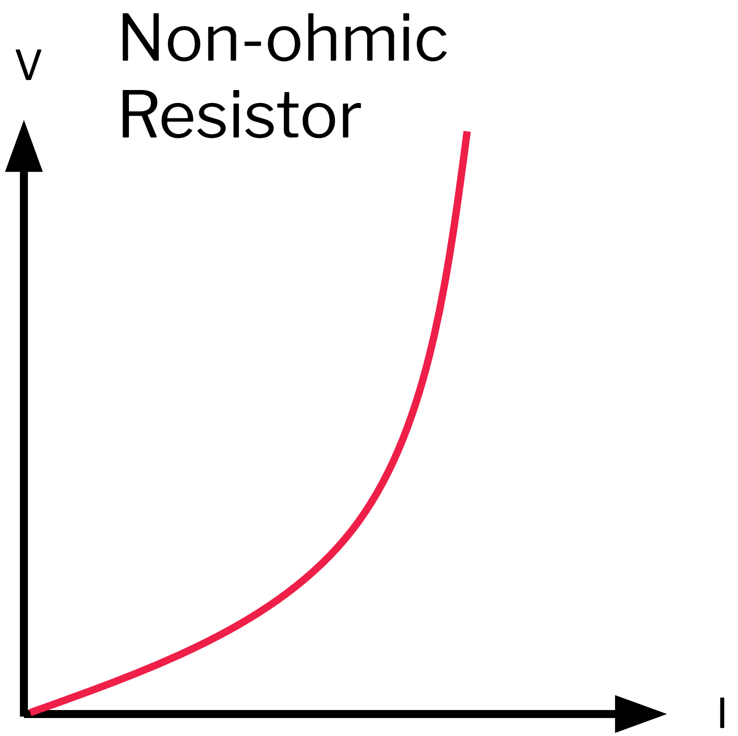
Electric circuit diagrams





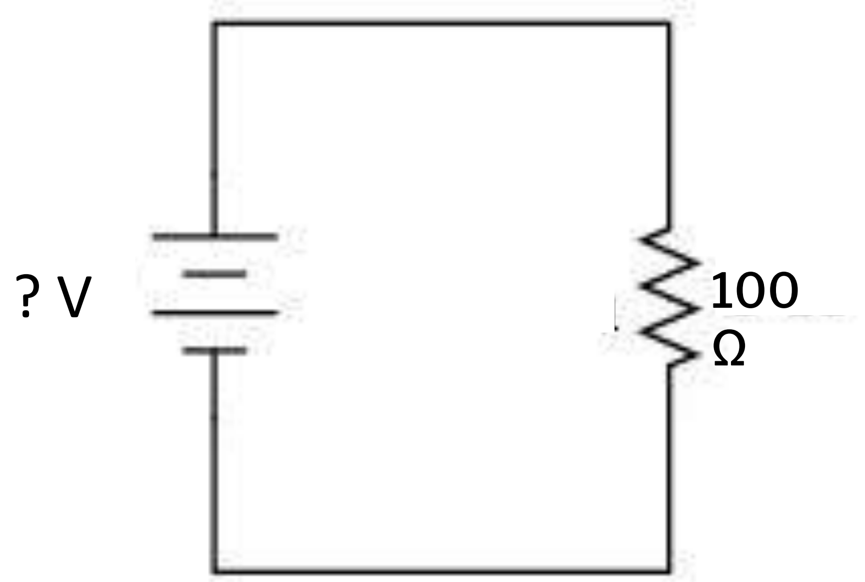
Ohm's law





gradient = rise/run = V/I = R

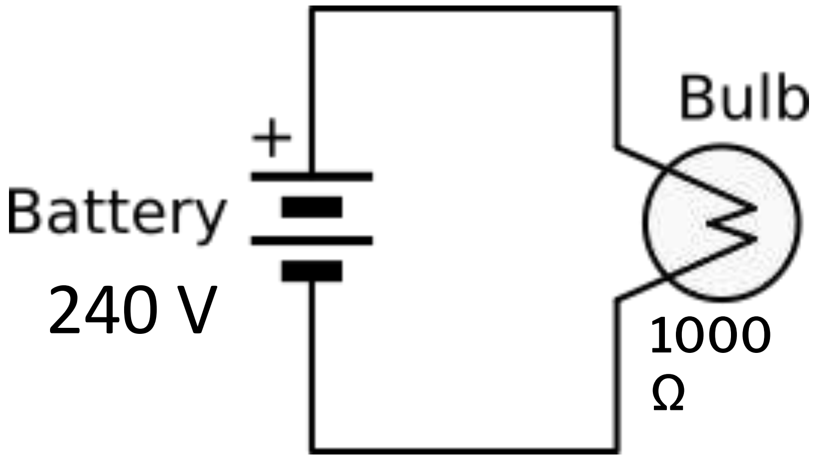
- Determine the voltage of the following circuit, given that the size of the current is 0.2 A



- You might need to:
  - use multiple equations together e.g. $P = VI = \frac{V^2}{R} = I^2R$
  - analyse multiple resistors

- What is the power rating of the following lightbulb:

$$P = \frac{V^2}{R}$$
$$P = \frac{240^2}{1000}$$
$$P = 57.6\ W$$

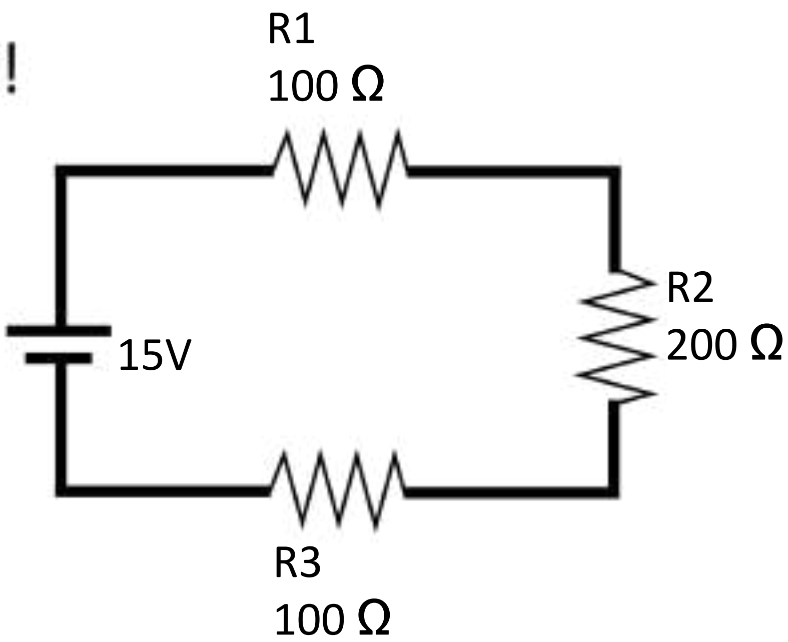


- For resistors in series you just add them together!

V= IR

V = I(R1 + R2 + R3)

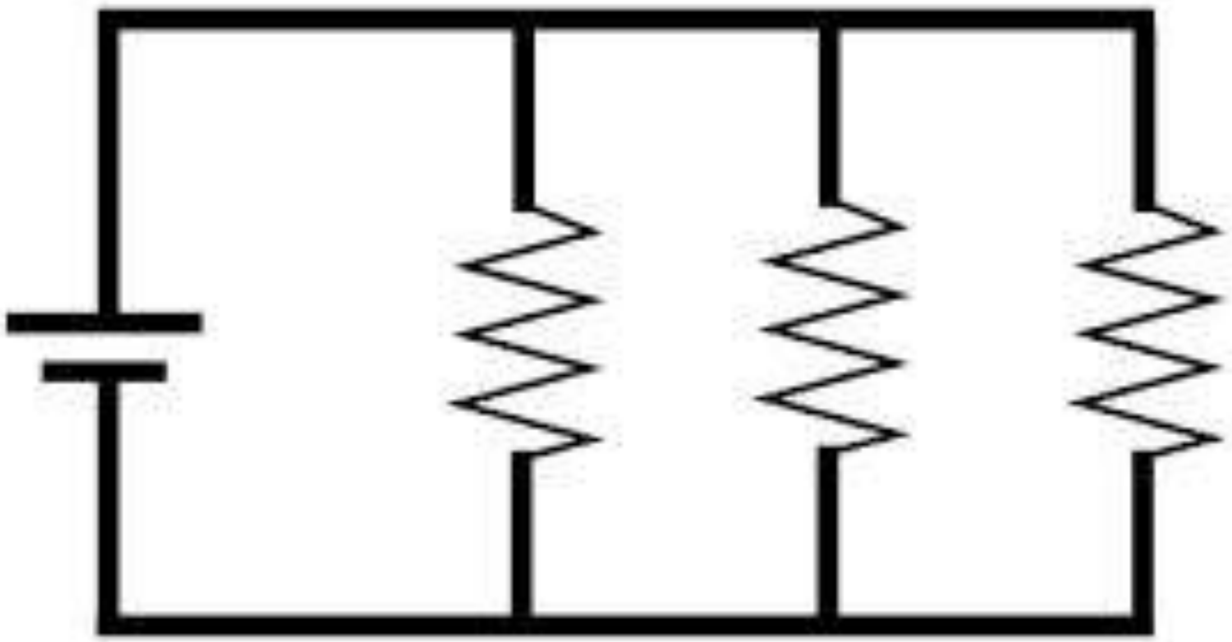
Therefore for the following circuit:



$$I = \frac{V}{R1 + R2 + R3}$$

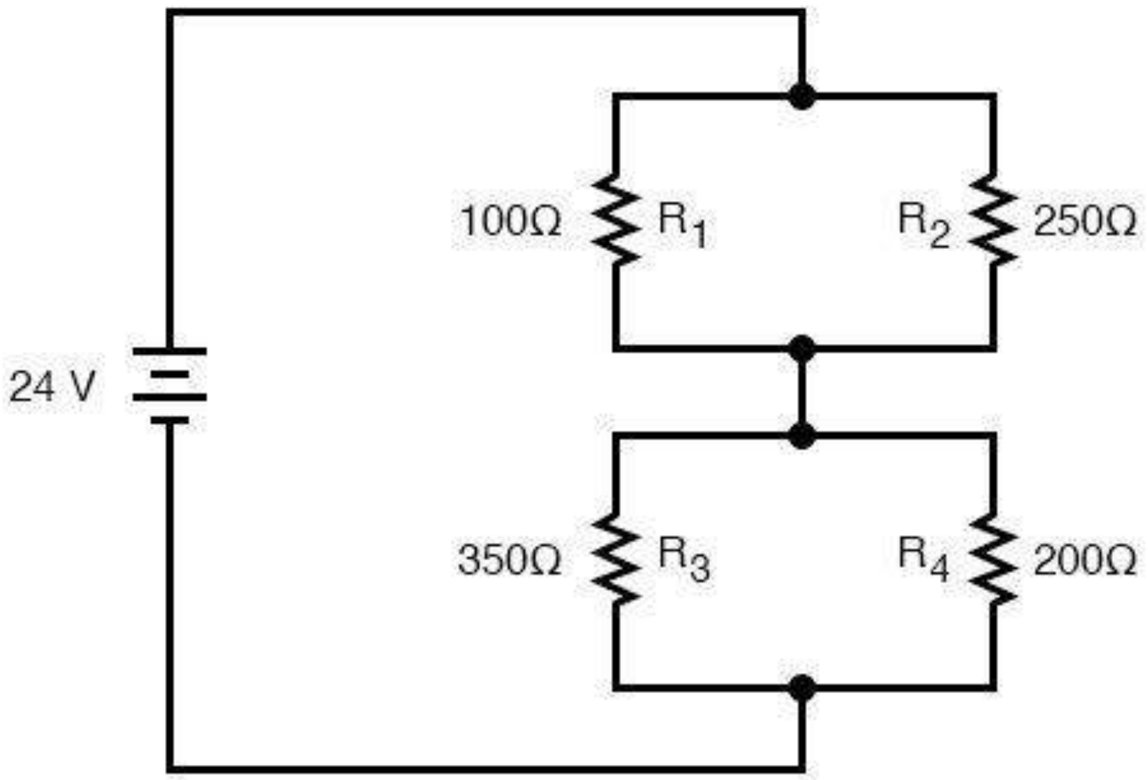
$$I = \frac{15}{400} = 0.04\ A$$

- Parallel circuits are a bit trickier:
- $1/R_{total} = 1/R_1 + 1/R_2$
- $I = V/R$
- $I = V(\frac{1}{R1} + \frac{1}{R2})$



Combination circuits

A series-parallel combination circuit



Resolve different resistor components, 1 step at a time.

Electrical safety

- Fuses: can only be used once, break the flow of current by melting

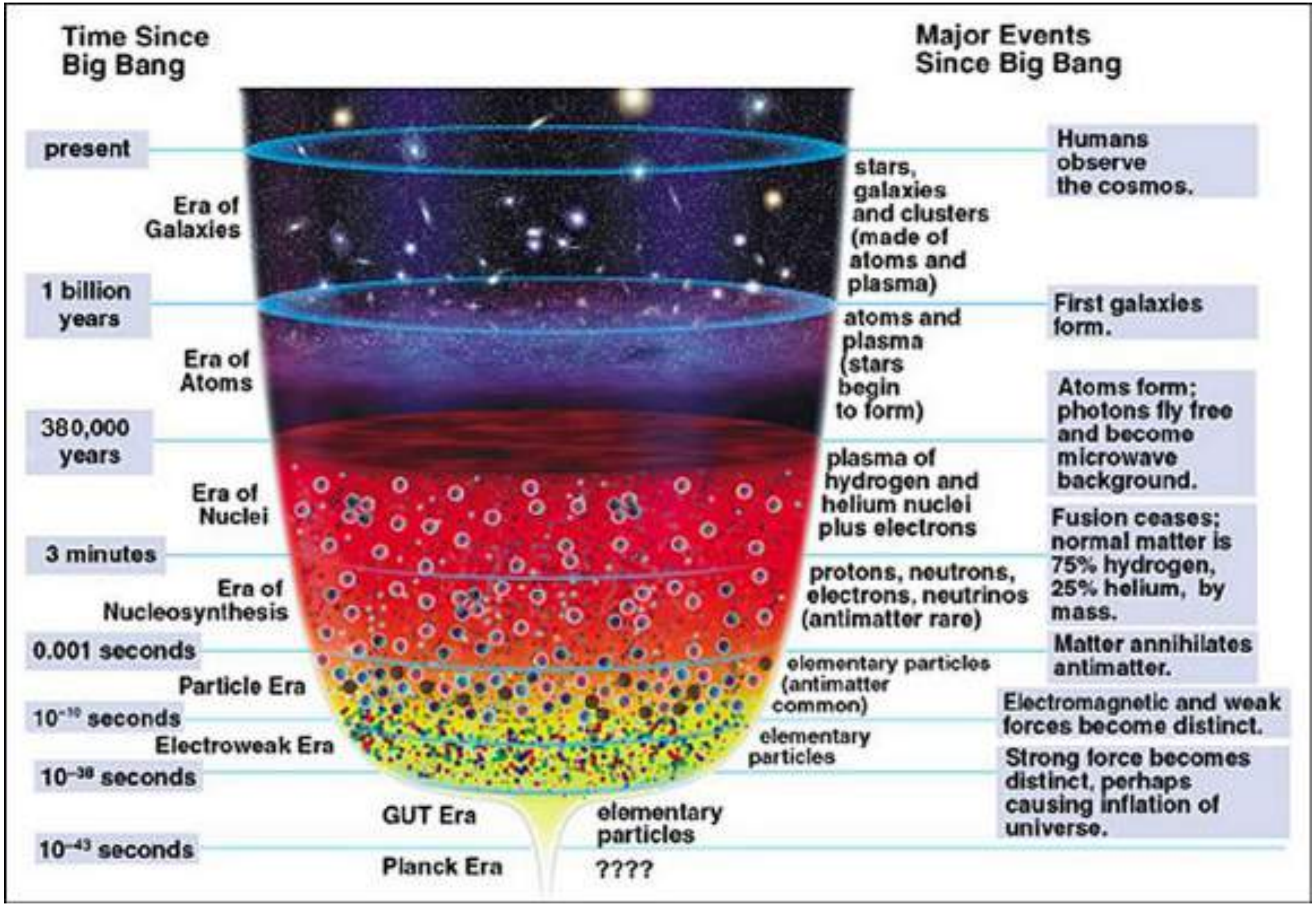
- Circuit breakers: can be reset to be used again, break the flow of current by opening as a switch when too hot

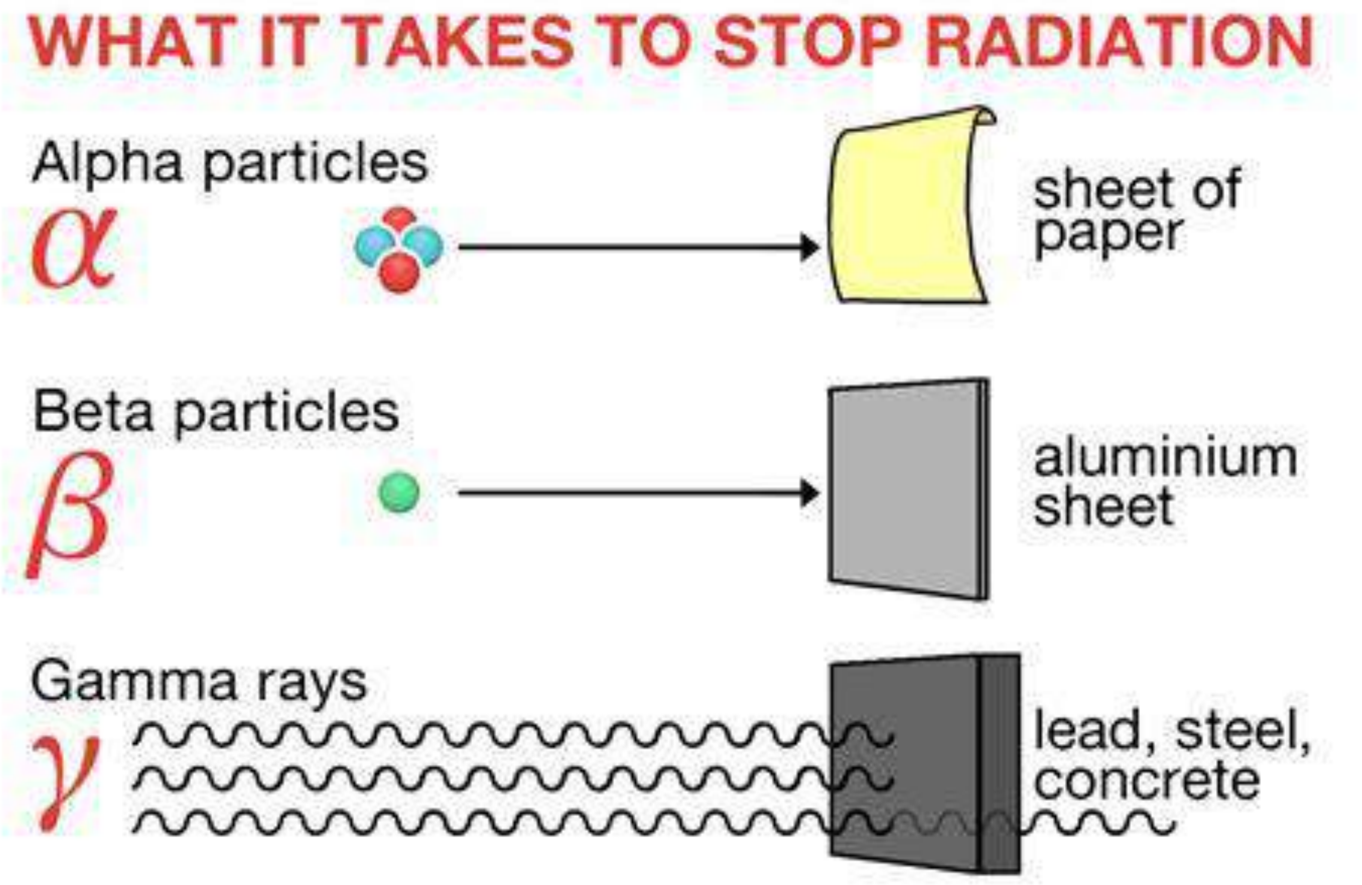
- Residual current devices, break a circuit when current to earth is detected

Big Bang

- The big bang is the accepted theory of the beginning of the universe
- It was a rapid expansion (not explosion!) from which we now have everything in the universe
- The universe is still expanding & cooling down
- We start counting time from the beginning of the big bang

Timeline of the universe



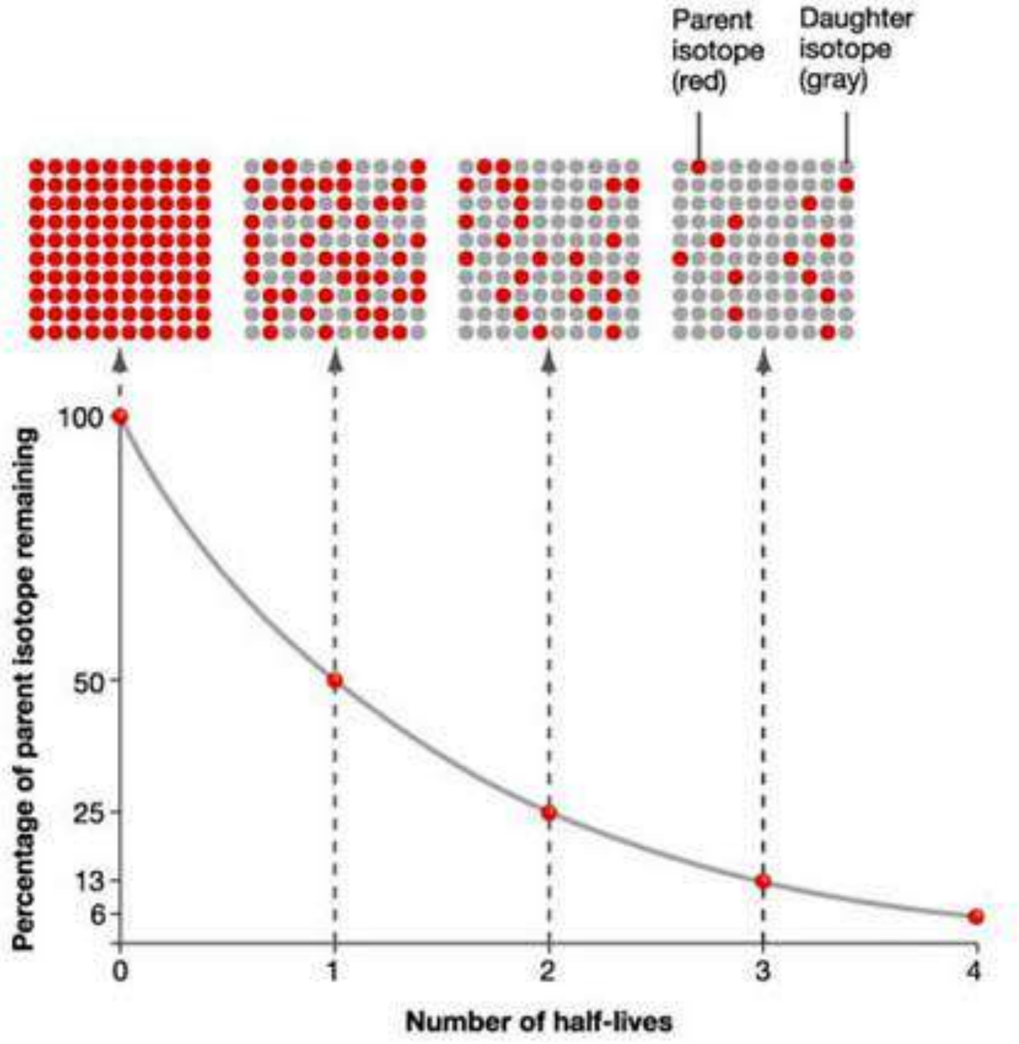


Alpha particle = Helium nucleus

Beta particle = Electron

Gamma rays = gamma EM radiation

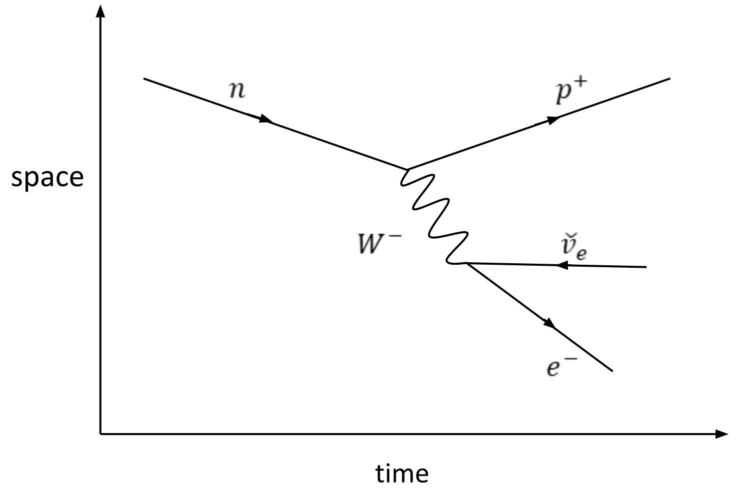
Radioactive decay



Each half life, half of the remaining substance decays

Why nucleons stay together?

- The strong force is very strong & it pulls nucleons together – but it only acts strongly over a very short distance
- The weak force is.... weak but it can change one kind of quark into another (example below of it changing a neutron to a proton)



Quarks

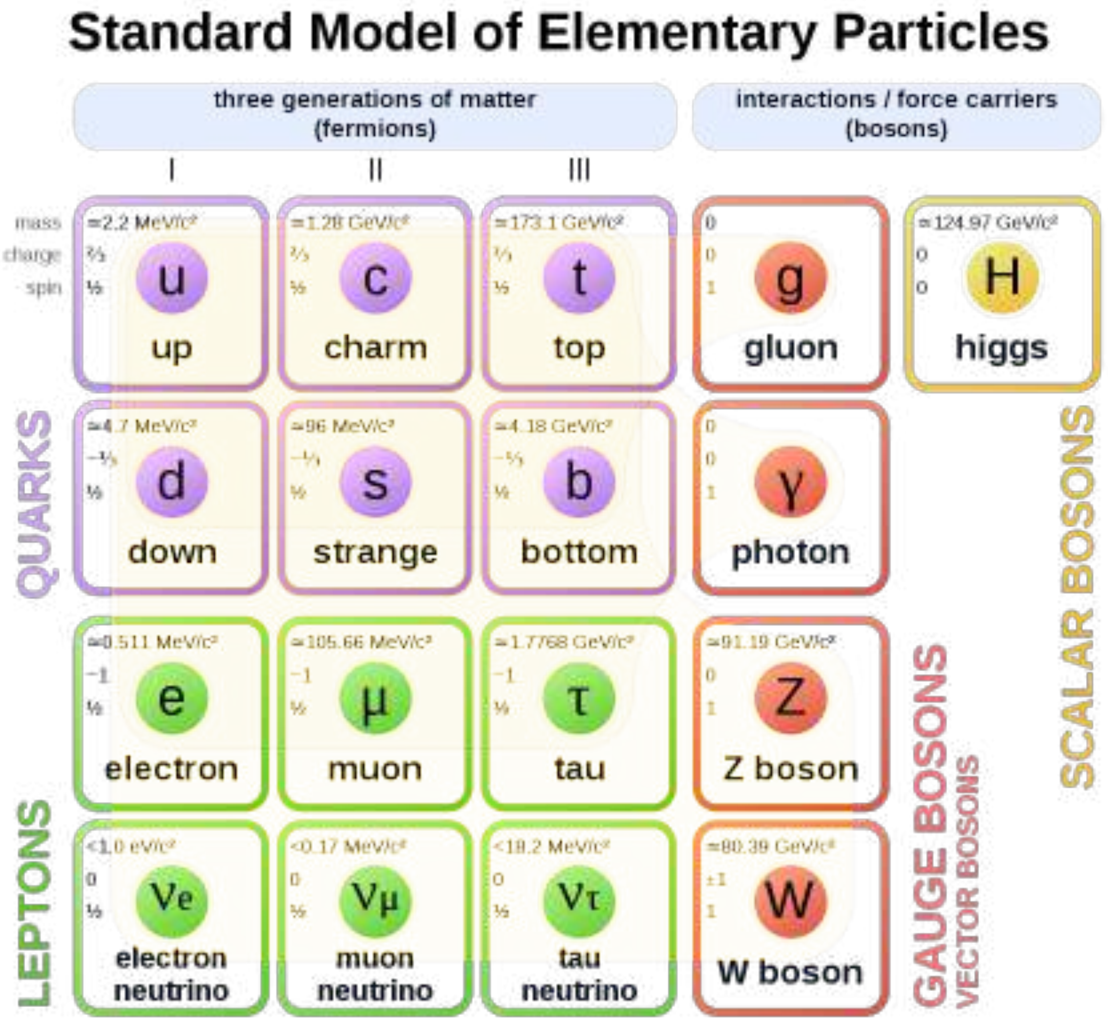
- Protons and neutrons are types of baryons made of 3 quarks each
- Protons are made of 2 up and 1 down quark
- Neutrons are made of 2 down and 1 up quark

Elementary charge (a proton has +1 elementary charge)	1st generation	2nd generation	3rd generation
+ 2/3	Up	Charm	Top
– 1/3	Down	Strange	Bottom (aka beauty)

- Leptons, unlike baryons (e.g. protons and neutrons) are not made of quarks

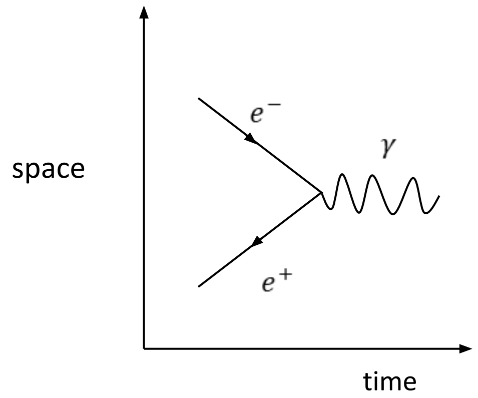
	1st generation	2nd generation	3rd generation
Charged	Electrons	Muon	Tau (aka tauon)
Neutrinos (Not charged)	Electron neutrino	Muon neutrino	Tau neutrino

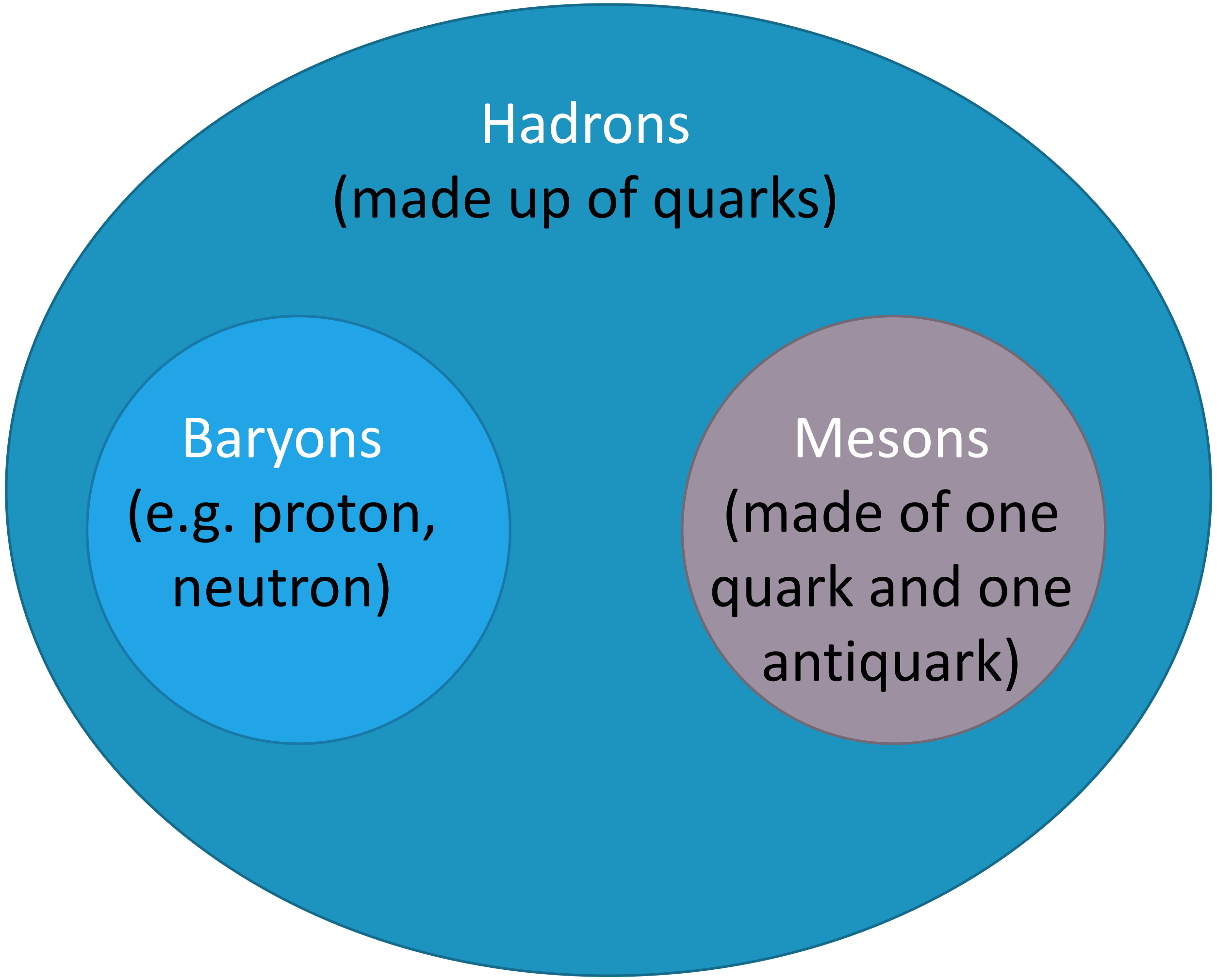
The Standard Model



Each matter particle (fermion) has a corresponding antimatter particle with equal mass and opposite charge.

If they meet, they will annihilate and create radiation (example below)





Could a meson be made of a quark and its antiquark?

$$E = mc^2$$

- E = energy, in Joules
- m = mass, in kilograms
- c = the speed of light, approx. 3×10^8 m s^{-1}

MASS-ENERGY EQUIVALENCE

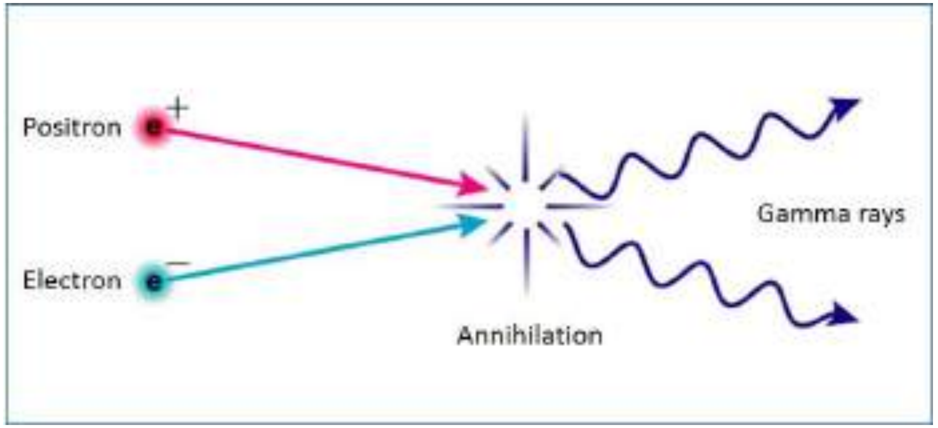
- Einstein equations reveal that there is an **inherent energy** associated with mass, known as the **rest energy**, E_0:

$$E_0 = mc^2$$

- This tells us that mass is energy and that energy is mass! This is the **mass-energy equivalence**.
- This formula tells us that **energy can be converted into mass** and vice versa
- Let's look at some common examples of where this might happen.

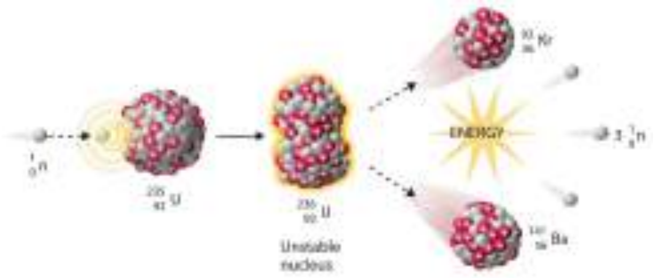
ANTIPARTICLE COLLISIONS

- An example where mass is converted into energy is when a **particle collides with an antiparticle**.
- We can use $E = mc^2$ to calculate the total energy produced from the total mass

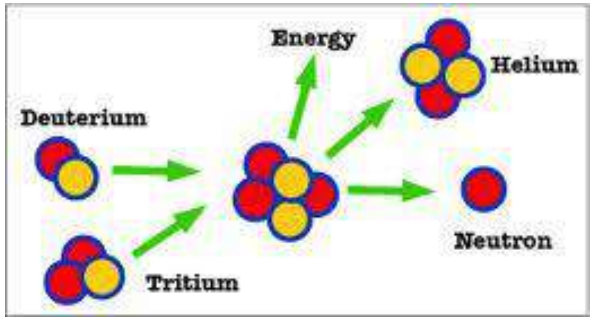


Fission and fusion

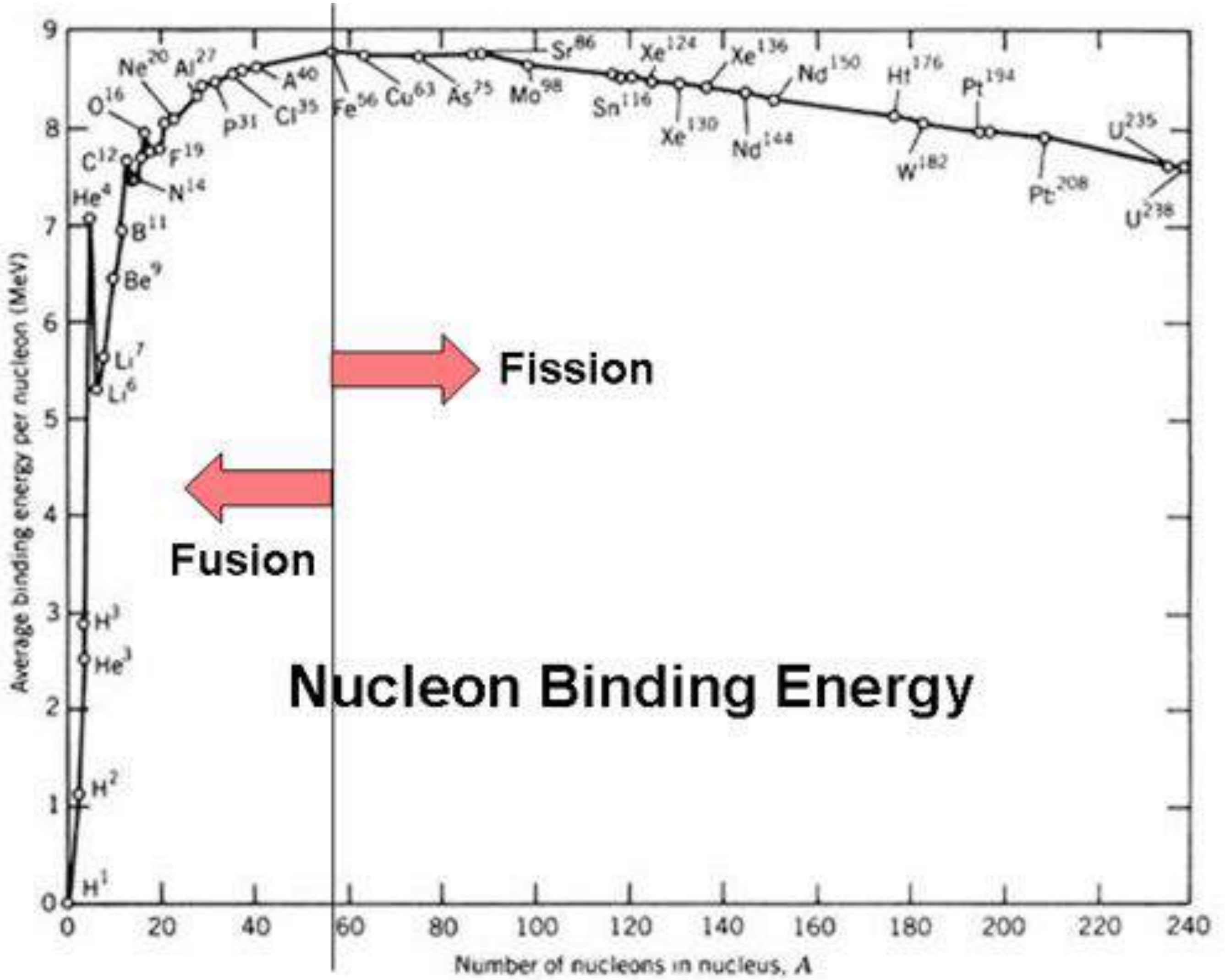
- Fission = breaking apart a nucleus into smaller nuclei (e.g. nuclear reactors, atomic bombs)



- Fusion = fusing (combining) nuclei together (e.g. in the sun)

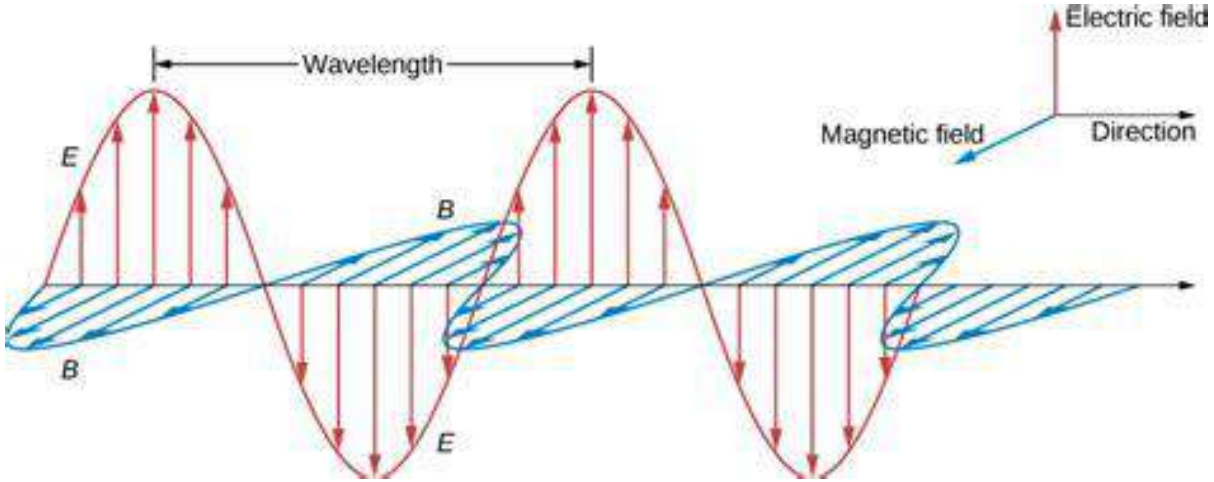


Binding energy curve



Light as an EM wave

- Light is a self-perpetuating oscillation of perpendicular electric and magnetic fields
- This is initially caused by a charged particle

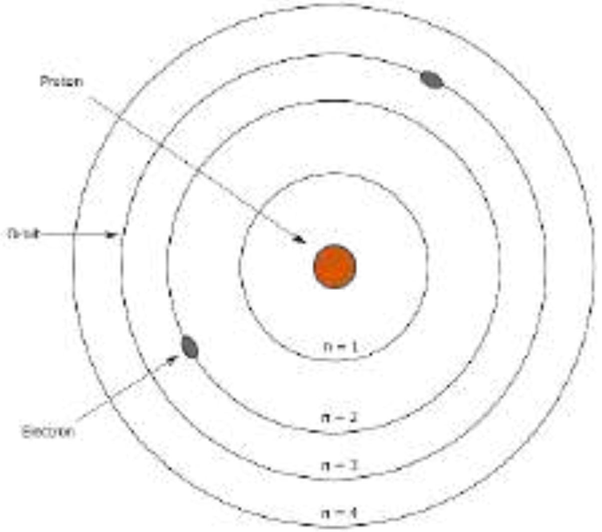


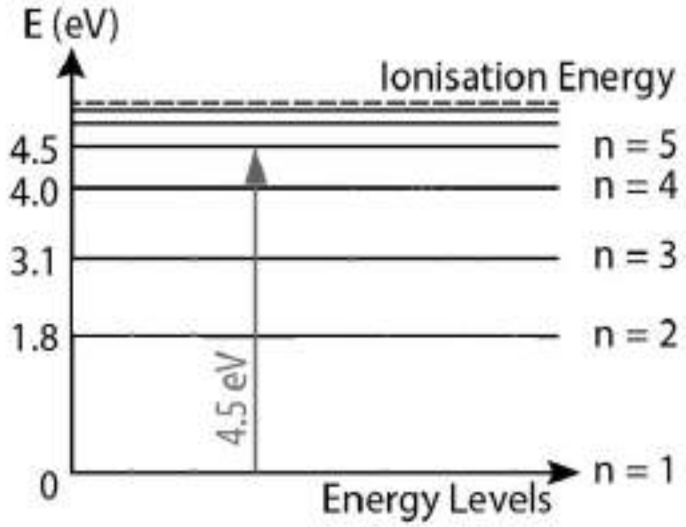
Synchrotron light

In a synchrotron, electrons are forced to travel quickly and turn

The electron radiates light energy at a tangent to its path

- Niels **Bohr** developed a model of the atom, allowing us to explain **atomic emission/absorption**
- In it, electrons are restricted to specific orbits





Variables

- An experiment explores how certain variables affect one another.

- There are three types of variables present in experiments:

- **Independent Variables** – the variable that is manipulated by the experimenter to see its affect on the dependent variable

- **Dependent Variables – **the variable that we measure to determine the affect the independent variable has on it

- **Controlled Variables** – variables that are kept constant during the experiment so that it does not affect the dependent variable

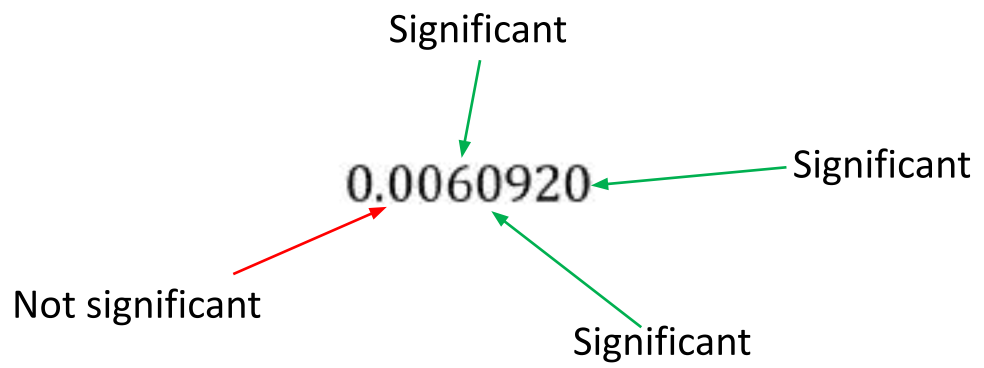
Scientific Skills

Sig figs

- When you take a measurement, the last digit has some uncertainty associated with it – we must use significant figures to maintain the level of precision associated with the measurement

Significant figure rules:

- Any 0’s to the *left* of the first non-zero digit are **not significant**
- All non-zero digits are **significant**
- All zeros between non-zero numbers are **significant**
- Zeros at the end of a number to the right of the decimal point are **significant**



When to use sig figs

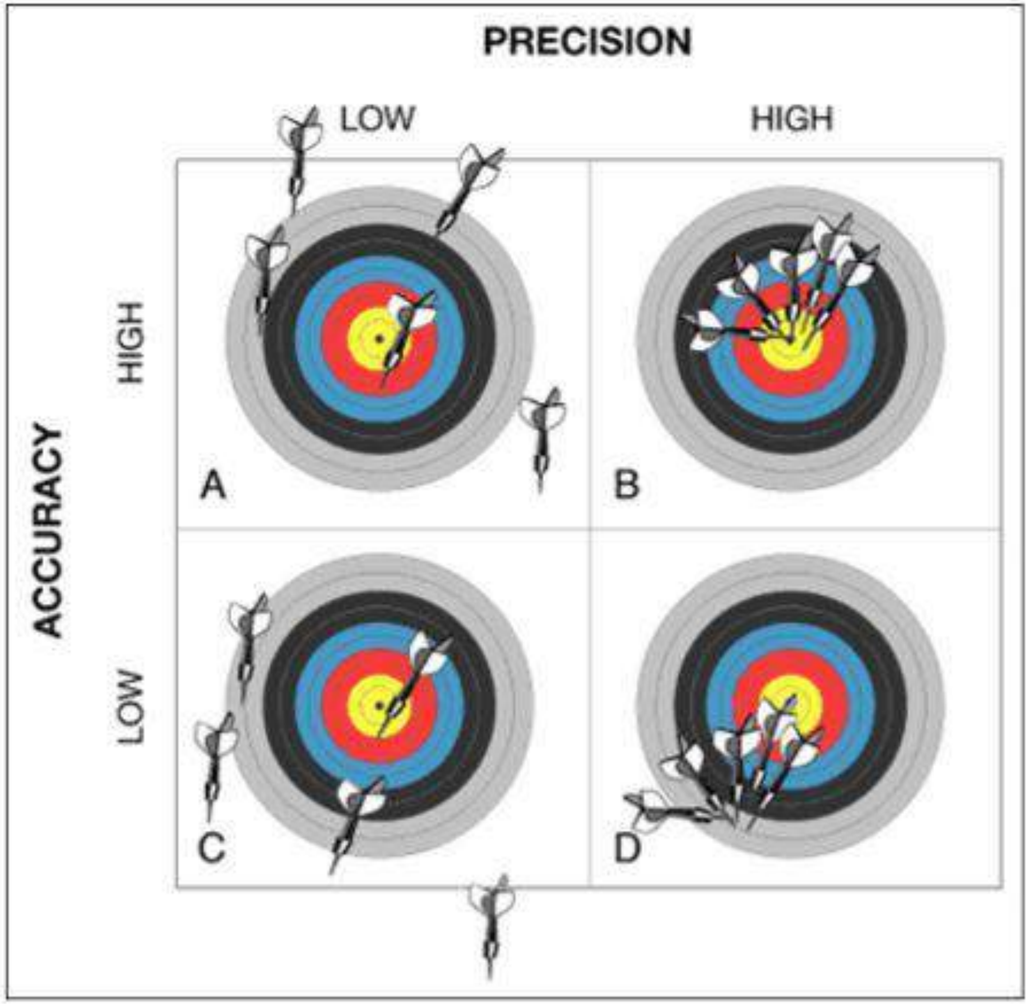
- **Adding and subtracting**
  - Final answer should have the **least number of decimal places** as the numbers added/subtracted
  - Eg. 0.5000 + 0.244 + 0.90 = 1.64

- **Multiplying and dividing**
  - Final answer should have the **least number of significant figures** as the numbers multiplied/divided
    - Eg. 15.600 x 4.033 / 0.742 = 46.7

Accuracy & precision

- **Accuracy** is a measure of how close a measured value is to its **true value**.
  - If a measured value/mean values are close to the true value, then the measurement is described as **accurate**. Otherwise, it is inaccurate.

- Measurements are **precise** if they are all **similar values**

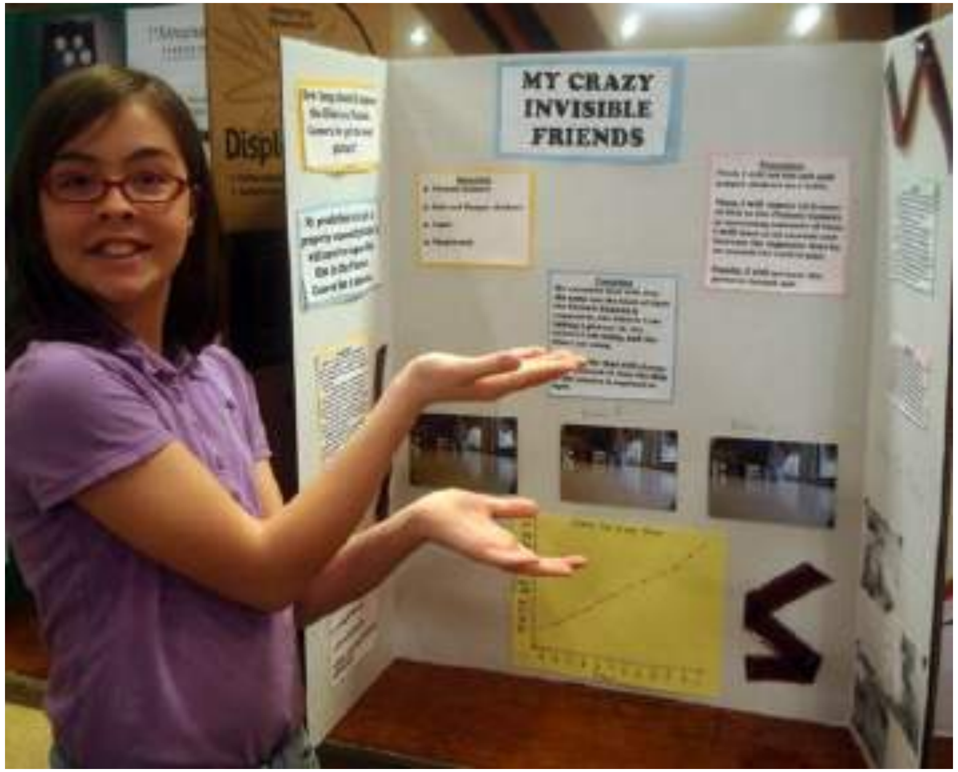


Uncertainty

- An **uncertainty** is an indicator of how **precise** a measurement is. The **smaller the uncertainty**, the **more precise** our measurement is.
- The uncertainty from a measuring device is simply taken as **half the smallest increment** on the measuring device.
  - For example, if your ruler makes measurements of length to the nearest mm, then your ruler would have an uncertainty of half a mm, or ±0.5 mm

The structure of a poster / report is normally divided into the following sections:

- Title / Question
- Aim
- Hypothesis
- Equipment
- Method
- Results
- Discussion
- Conclusion
- References (sometimes)



Title

- The title should fully describe what is being investigated in your experiment, and should be *clear*, *concise* and *easy to understand*.

- Note: some schools may prefer that you frame the title of your poster/ report as a question.

- *Incorrect:*
  - Temperature Changing the Resistive Force and what role does Viscosity Play?

  - Angle will change the acceleration on a plane that is inclined with the acceleration?
- *Correct:*
  - The Effect of Temperature and Viscosity on the Resistive Force a Liquid Provides

  - How Does the Angle of an Inclined Plane Affect Acceleration?

BACKGROUND INFORMATION, HYPOTHESIS, AIM AND METHOD

Background information: Outline the general theory behind the experiment, and specify any key terms / equations used throughout.

Aim: State the primary objective of the experiment. Normally, this can be summarized into a single sentence.

Hypothesis: A brief statement outlining the expected outcomes for the experiment. An 'educated guess' of what will happen.

Method: A complete set of instructions describing how to replicate the experiment. The method can contain as many steps as required but should also be quite concise.

Note: The general rule of thumb is that *any* general year 12 physics student should be able to repeat the experiment after reading through the method.

RESULTS

- Make detailed observations and notes during the experiment
- Try to collect data in a tidy and organized manner – even during the experiment – a table is usually the best way to go
- Data should be presented in a way that is simple, clear and easy to understand.

Data that is poorly presented:

Confusing Title

Different masses used for different springs?

Mass Spring 1	Mass spring 2	Mass spring 3	spring Extension
500.0	500	5×10^2	0.05 m
800	1×10^3	1.0×10^3	10
1100	1500	1500	14 cm
1500	2.00×10^3	2000	18 cm
1900	2500	2.50×10^3	24 cm

No units

No uncertainty in measurements?

Inconsistent Sig. Figs

Inconsistent units

Data that is presented well:

Unit and uncertainty in title

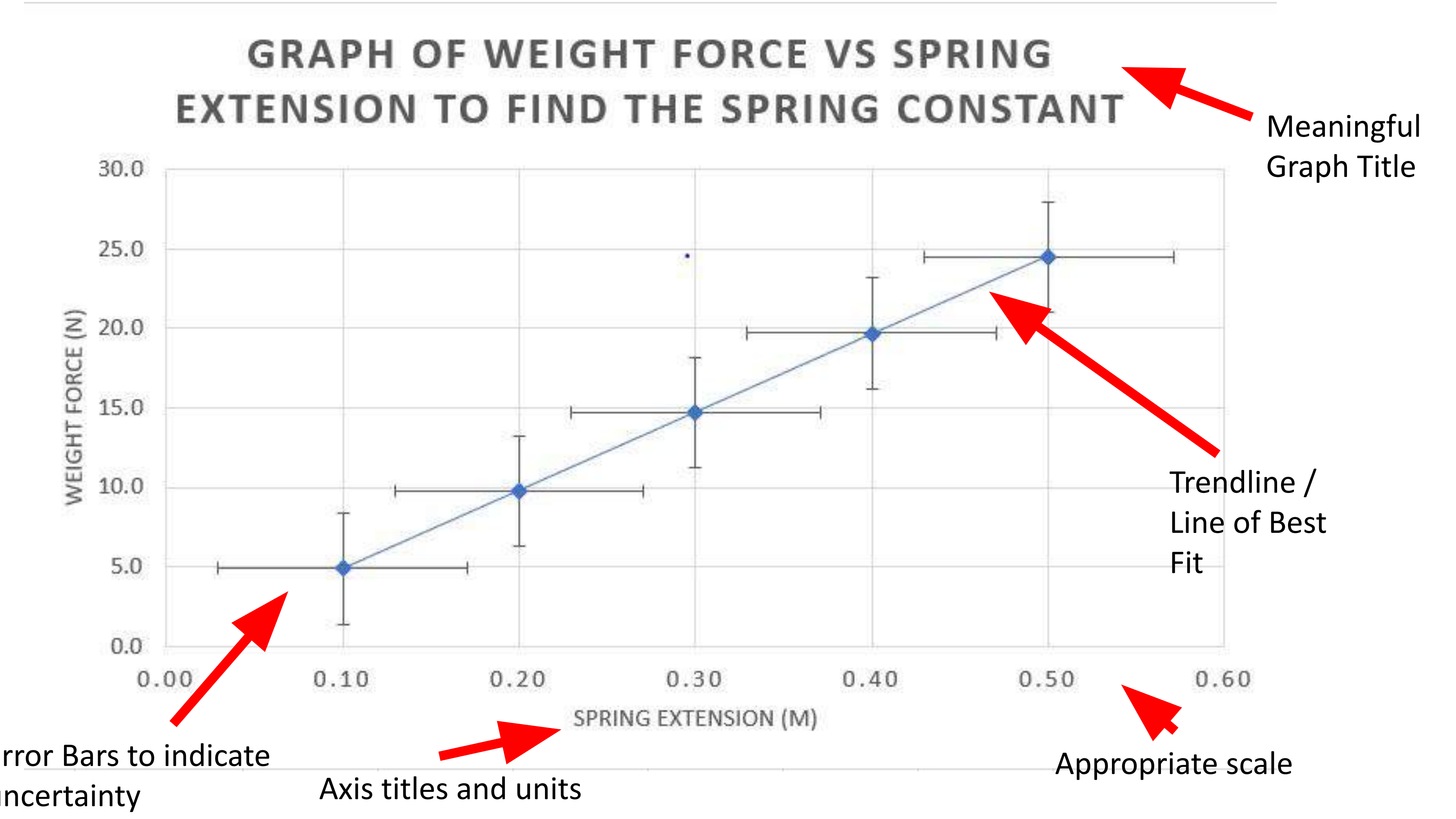
Consistent weights used for each of the three springs

Clear titles

Mass (kg) (±0.05)	Weight Force (N) (±0.5)	Spring Extension (m) (±0.005)		
		Spring 1	Spring 2	Spring 3
0.5	5	0.05	0.10	0.09
1.0	10	0.10	0.20	0.18
1.5	15	0.15	0.30	0.27
2.0	20	0.21	0.40	0.36
2.5	25	0.26	0.50	0.50

Consistent precision

RESULTS - GRAPHING DATA



WHAT TO TALK ABOUT IN THE DISCUSSION

- The **discussion** is arguably *the most important part of your report*. A lot of marks are in the discussion.
- Essential things to include:
  - ❑ An analysis of your results and an interpretation of their meaning
  - ❑ Link the outcome of your experiment to the hypothesis and established theory
  - ❑ A discussion of possible errors in the experiment and the influence they may have had on the accuracy of your results
  - ❑ The limitations of your experiment
  - ❑ Possible ways to improve the design of your experiment

FINAL TIPS

- Keep it simple. Keep it *concise* – make sure there are no unnecessary details
- Write in third person
- Read the rubric your school provides you with – the specifications will be different for every school

http://www.vcaa.vic.edu.au/Pages/vce/adviceforteachers/physics/suggestions_for_effective_scientific_poster_communication.aspx